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J. F. WILSON[1]

INTRODUCTION

The desirability of placing the fleece weights of sheep on a clean basis has been recognized by sheep breeders and wool specialists. The shrinkage of wool, and consequently the grease weight of the fleece, varies with the breed of sheep, the individuality of the animal, its care and management during the period of growth of the fleece, seasonal variation, the length of the fleece, climatic and soil conditions under which the sheep are run, and moisture content. Wool may vary in shrinkage from about 30 per cent to about 80 per cent. It is obviously fallacious, therefore, to compare the fleece weights of individuals of the same breed or of individuals of different breeds, unless the fleece weights are on a clean basis.

Data from the wool laboratory of the University of California[2] show that sheep of the same breed, kept together in the same fields during the entire period of fleece growth, may vary as much as 10 per cent in shrinkage. Such a difference means that a fleece weighing 12 pounds and having a 60-per-cent shrink yields the same amount of clean wool as a fleece weighing 16 pounds and shrinking 70 per cent. Yet most breeders would consider a fine-wool ewe producing a 12-pound fleece a light shearer, but would consider the ewe producing a 16-pound fleece of grease wool entirely satisfactory.

Practically all standard texts used in teaching animal husbandry laud certain breeds on account of their heavy wool production, while other breeds are criticized as being light shearers. To quote from one modern text: "The American Merino as a wool producer is famous. No class of sheep shears . . . . so heavy a fleece. Many mature females shear from 12 to 15 pounds." The same text, in discussing the Shropshire breed, states "Coffey gives the average weight of fleece at 8 to 10 pounds." These weights are all on a grease basis and the reader of the text is led to infer that the comparison of fleece weights of the two breeds is a direct one. It is possible that if the fleeces of the

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[2] Advanced registry records.

American Merinos and Shropshires were scoured, the difference in the shrinkage of the two breeds under similar conditions would be the difference between 65 per cent and 48 per cent. Assuming these figures of fleece weights and of shrinkages to be approximately correct, the clean weight of the American Merino fleeces would be 4.20 to 5.25 pounds, while the Shropshire fleeces would weigh 4.16 to 5.20 pounds, or practically the same as the Merino.

The idea of establishing an advanced registry for fine-wool sheep was suggested by Miller,[3] after a conference with W. T. Ritch, an Australian wool expert who was visiting at this station.

In California an advanced registry of Rambouillet sheep is maintained at the present time as an activity of the California Branch, American Rambouillet Breeders' Association. The rules and regulations governing the admittance of animals to advanced registry were developed by the writer in conference with Rambouillet breeders. These rules require ewes to shear a minimum of 5.25 pounds and rams a minimum of 7.7 pounds of clean or scoured wool in twelve months' growth. The work incident to the inauguration of this advanced registry for sheep necessitated devising a means of obtaining clean weights of fleeces. This publication attempts to describe the procedure, which has been evolved by the trial method.

Within the past three or four years, states other than California have manifested interest in advanced registry of sheep. Several agricultural colleges, too, have evinced a desire for information as to how properly to scour small samples of wool. It is hoped that this publication will answer the questions relative to experimental wool scouring and serve as a guide to those interested in the subject; also that it may lead to placing comparative fleece weights on a scoured or clean basis, the only basis upon which real progress in breeding for heavy wool production can be made.

THE PROBLEM OF EXPERIMENTAL SCOURING OF WOOL[4]

Experimental wool scouring should be undertaken with a view of eliminating, insofar as is possible, experimental error. The methods employed by most commercial scouring plants, in which no attempt

[3] Miller, Robert F. Advanced registry for fine wooled sheep. Natl. Wool Grower 8(1):38–40. 1918.

[4] Wool-scouring work has been carried on by several stations, notably those of Wyoming and Texas, and by the United States Department of Agriculture at Beltsville, Md. However, the methods employed at these and at other stations, in obtaining the clean weights of individual fleeces, differ from the method described in this paper. They are either small commercial-type plants or else do not provide for obtaining a homogeneous sample of the entire fleece for the scouring operation.

is made to put the work on a standard-moisture basis, are obviously unfitted for experimental purposes. Furthermore, in commercial wool scouring, it is not always customary to try to remove all of the foreign matter in the wool, but only a sufficient quantity to allow the stock to work well in subsequent manufacturing processes. Especially is this true of plants which offer scoured wools for sale. In experimental work, on the other hand, the method employed should be one which will remove all of the dirt and all of the yolk except that which is a component part of the fiber itself. In other words, if two identical lots of wool were to be scoured, one commercially and one experimentally, the latter should have the higher shrinkage, if any variation in results appears.

FIRST ATTEMPTS AT SAMPLE SCOURING AT THE UNIVERSITY OF CALIFORNIA

An almost complete absence of printed literature descriptive of scouring small quantities of wool necessitated the gradual evolution of the method herein described. At first it was decided to scour whole fleeces. A wooden vat was constructed in a manner which simulated the three-bowl scouring machinery used in commercial plants. Baskets made of hardware cloth were constructed to fit tightly inside each of the three 'bowls' so that after the wool had been scoured the entire mass could be lifted out without losing any of the wool. This method was wholly unsatisfactory. The amount of wool in the volume of scouring solution was so large as to prevent free movement of the stock through the solution, a cardinal principle in scouring wool. Yet had the capacity of the tubs been increased to permit free movement of the stock, the time required to heat the water to the desired temperature would have made progress very slow and the cost of all operations relatively high. Furthermore, it was found that a large fleece, when wet, was so heavy that two men were required to lift it from the tubs.

Determining the clean weight of a fleece by scouring samples was then undertaken. A representative sample was obtained by spreading the fleece out, weather end up, on an Australian type of skirter's table. The fleece was sorted into back, shoulder-sides-and-neck, belly, britch, tags, and pieces. Each of these sorts was weighed in grams, and the percentage of the entire fleece which each sort represented was calculated. A 500-gram sample was then made up, containing the same percentage of each sort as was contained in the whole fleece. For

instance, if the belly constituted 5 per cent of the weight of the fleece, then 25 grams of belly wool was put into the 500-gram sample. The shrinkage of the sample was taken as the shrinkage of the fleece and the clean weight was calculated.

This method greatly reduced the amount of hard manual labor involved and permitted more than one test on each fleece. However, the time required to sort the fleece and to make up representative samples was so great that only one or two fleeces could be tested in eight hours and the large number of weighings and calculations involved increased the possibility of error.

A further disadvantage lay in the fact that so much manual manipulation of the fleece caused some of the dirt to be lost, and this affected the results. Had the loss been evenly distributed, the error would not have been serious, but it is obvious that those sorts which normally contain the bulk of loose dirt, namely the back and britch, lose in manipulation a larger proportion of their weight than do the shoulder or neck. The scoured product obtained by this method was fairly satisfactory.

It was realized that if the fleece could be thoroughly mixed up into a homogeneous mass, samples of any convenient amount could be taken at random, any one of which would, theoretically, represent the fleece. Attempts were made to mix the fleece by hand, by breaking it into small locks and then turning this mass over repeatedly with a silage fork, but this plan proved too laborious.

THE UNIVERSITY OF CALIFORNIA METHOD FOR EXPERIMENTAL SCOURING OF WOOL

The method of experimental scouring now used has been tested thoroughly. Its accuracy, simplicity, and economy indicate that the principles involved in its operation might be adopted by experiment stations at which wool-scouring work is contemplated. The following equipment is involved:

(*a*) A means for heating water directly in the scouring tubs. Temperature of the bath must be initially the same for each lot of wool, otherwise the results will not be comparable. Several samples may be scoured in each tub before replacement of the scouring solution is necessary, hence it is advisable to use either direct injection of live steam into the tubs or to provide gas burners which will permit reheating the bath to the desired temperature. Of these two methods, the gas is preferable since direct injection of steam dilutes the bath with condensation.

Fig. 1.—Fleece breaker. This machine breaks up the fleece into small locks and makes it into a practically homogeneous mass preparatory to scouring.

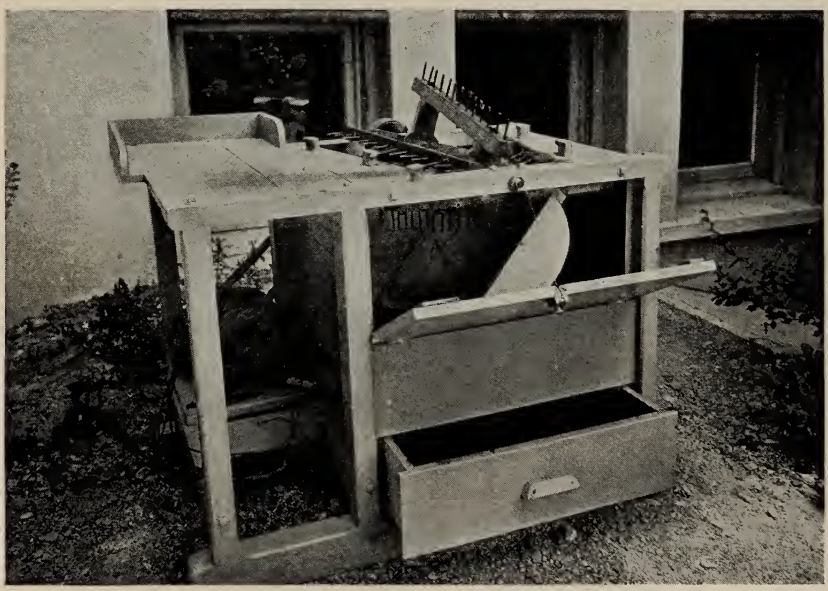

Fig. 2.—Interior construction of the fleece breaker. The lower cylinder housing is made of hardware cloth on a wooden frame and is hinged so that it can be dropped down for cleaning out the machine. Dirt removed by the action of the cylinder passes through this lower housing and falls into the drawer below.

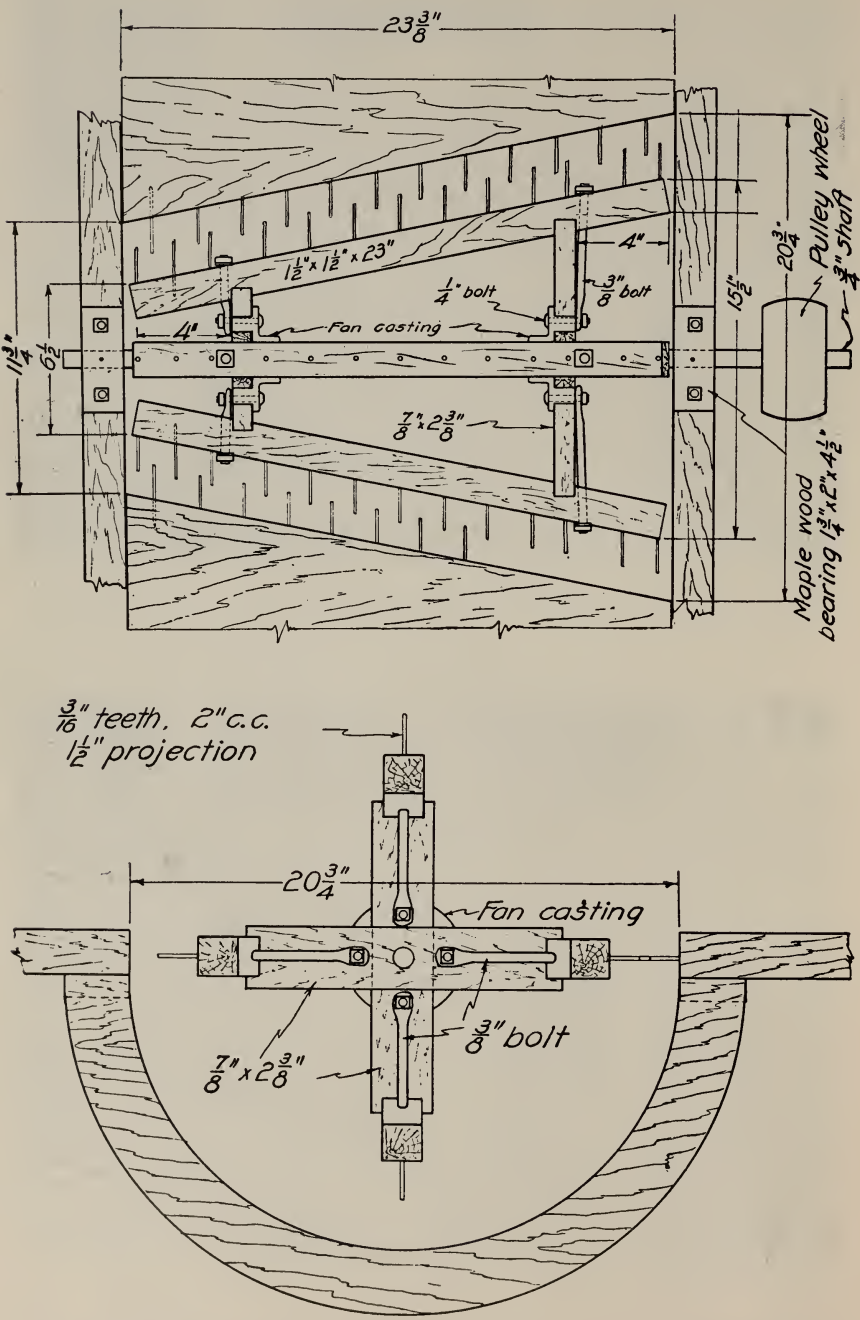

Fig. 3.—Detail of breaker cylinder. *A*, top view; *B*, view of large end.

(*b*) Balances. A balance with a capacity of 20 kilograms and a sensibility of one or two grams is sufficiently accurate for determining the grease weight of the fleece. An additional balance with a capacity of from 200 to 500 grams and sensibility of one centigram should be used for weighing out the samples before and after scouring.

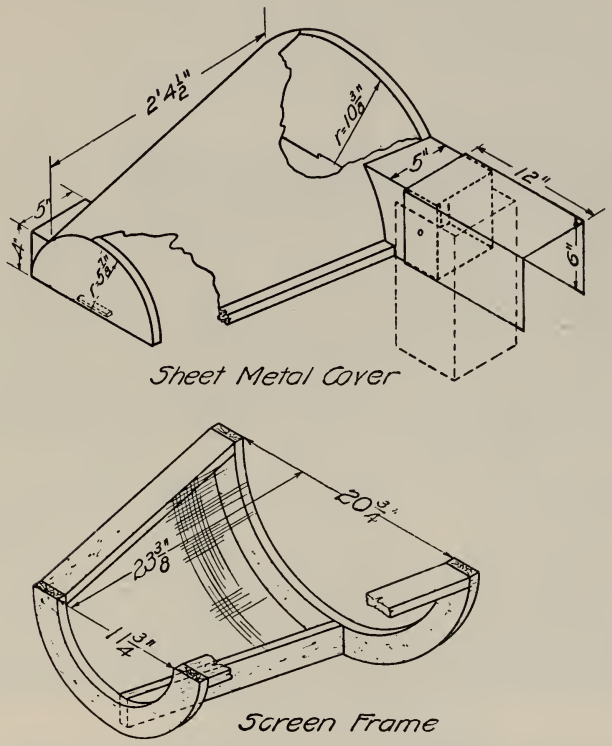

Fig. 4.—Details of top and bottom cylinder housing.

(*c*) A device for mixing the wool thoroughly and opening the tip, or weather end, so that the scouring liquor may permeate the stock quickly and evenly. For this purpose a machine embodying the principle of the cone-type duster used in many commercial plants has been designed and built at the wool laboratory of this institution. The construction of the machine is so simple that it may be easily built by a carpenter and the metal parts required are all standard. Its cost need not exceed $100.00, including a ¾-horsepower motor. For wools coarser than ⅜ blood, the dimensions of the breaker should be increased; otherwise the long fibers will have a tendency to become wrapped around the small end of the breaker cone. Figures 1, 2, 3, and 4 show the detailed construction of the apparatus.

(*d*) Four medium-sized galvanized-iron wash tubs. Three of these are used to hold the scouring liquors and the fourth contains the rinse.

(*e*) One small galvanized-iron tub with galvanized fly-screen bottom (fig. 5).

(*f*) A heavy commercial laundry wringer (fig. 6).

(*g*) A wooden paddle about two feet long for agitation of the wool in the scouring solution (fig. 5).

(*h*) A device for drying the scoured wool (fig. 7).

Fig. 5.—Tubs used in scouring the samples. The bottom of one of the tubs has been replaced by galvanized fly screening. This tub fits inside each of the others during the scouring process and is used to lift the sample from the scouring solutions.

(*i*) An oven in which the bone-dry weight of the scoured wool may be obtained, or a room so located or constructed that the humidity and temperature remain practically constant. It is not necessary to standardize the conditions under which the grease weight of the fleece is obtained, since fluctuations in grease weight due to atmospheric changes are merely reflected in greater or less shrinkage. It is absolutely essential, however, that the scoured wool be weighed under constant or controlled conditions. The Emerson textile-conditioning oven has been found satisfactory for this purpose. If neither the conditioning oven nor the constant temperature and humidity room is available, scoured samples may be stored in any convenient room,

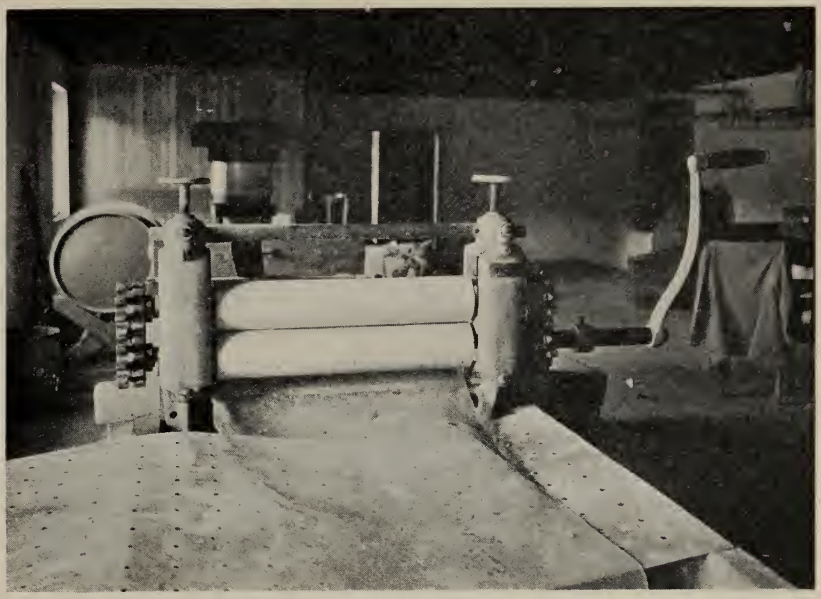

Fig. 6.—Type of wringer found satisfactory for scouring small samples of wool.

Fig. 7.—The wool dryer; an adaptation of the sirocco-type blower. The air-heating device is not shown.

preferably in a basement, and weighed at such times as a sling psychrometer indicates a certain humidity. Such an arrangement is satisfactory only if the fluctuation in humidity is comparatively small, on account of the 'lag.'

METHOD OF PROCEDURE

1. The fleece is first weighed in grams. Heavy dung locks, shanks, twine, and other foreign material should be weighed back and the total subtracted from the gross grease weight. These 'offs' do not properly belong in the fleece. Ordinary tags and sweat locks may be separated out and the entire quantity scoured separately. The clean weight of these is added to the clean weight of the fleece. The fleece is then fed through the "breaker" and the weight again taken. The difference represents shrinkage due to loss of dirt; the loss, expressed in per cent, is later used to calculate what the original grease weight of the samples would be had they not been fed through the machine. It is advisable to put the wool through the breaker two or three times in order to mix it thoroughly.

2. Three samples are then made up by extracting from various parts of the basket enough small bits of wool to make up the amount desired. While it is obviously unnecessary to use exactly 100 or 200 grams, such an amount saves record keeping and also facilitates calculations of yields and shrinkages.

3. Seven gallons of water and about 60 grams of soda ash are added to each of three tubs and the temperature of the solution is raised to 125° F.

4. Neutral soap, such as is used in commercial plants, should be used. This soap in solid form comes in barrels. While most wool scourers prefer the coconut-oil soap, that made from cottonseed oil is usually cheaper and will also be found satisfactory. The soap in the solid form should not be added to the tubs, owing to the fact that small bits may not dissolve readily and may get into the wool. About two pounds of the solid soap should be placed in a three-gallon pail and about two gallons of water added. The soap is then heated and stirred until it has completely dissolved. A large beaker or dipper may be used to transfer this soap stock to the tubs.

There is no definite unit of measure of the correct amount of soap for the scouring bath. Weighing the solid soap accurately is of no avail, since its moisture content varies greatly, especially after long storage. Insufficient soap fails properly to cleanse the wool, while too great a quantity will cause the wool to become ropy and partially to felt. Felting of the wool prevents effectual penetration of the scouring liquor. The best indication of the optimum amount of soap in the scouring bath is the appearance at the time the wool is passed through the wringer. Best results will be secured when soap bubbles appear freely but disappear quickly as the wool is being fed through the

rollers. If the bubbles are copious and tend to linger on the wool when the wringer is stopped, the bath contains too much soap.

For work in connection with experimentation involving the scouring of many samples, all of the soap stock should be made up at one time. One or more samples of wool not involved in the project may first be scoured in order to ascertain the correct amount of soap. If the soap solution is made up at such a concentration that it is gelatinous at room temperature, between 450 and 500 grams of the liquid soap will probably be found correct for each tub.

5. A tub one size smaller than those containing the scouring bath is used to hold the 100-gram sample of wool. The small tub should have the bottom replaced by galvanized fly screening (fig. 4). This tub, containing the wool, is immersed in one of the larger tubs. The wool is stirred *gently* with the wooden paddle. After from two to four minutes' immersion the smaller tub is lifted out of the bath, and the wool is put through the wringer. It is then replaced in the screen-bottomed tub, which is now immersed in the second tub. This operation is carried on three times, after which the sample is rinsed in the fourth tub which contains only water heated to about 85° F. After thoroughly rinsing, the wool is placed in the dryer.

6. The dryer should be operated at not over 160° F. Wet wool dried at temperatures higher than 160° F may become yellow, harsh, and brittle.[5] The dryer should provide as rapid a current of warm air as it is possible to obtain, if quick drying is desired. Sun drying is not as satisfactory as artificial drying, on account of the greater length of time required and also because of the danger of losing small particles of wool and the possibility of dust and other foreign matter getting into the samples.

7. After the samples have been reduced to air dryness they should be transferred to the conditioning oven where, after about one hour at 220° F, the bone-dry weight may be taken and the normal weight, based on the standard regain, calculated. If weights are to be taken in a constant temperature and humidity room, the samples should be allowed to regain for at least 24 hours, and preferably two or three days, before weighing.

8. After weighing the scoured samples, the yield of each is calculated and the average yield of the three samples is taken as the yield of the entire fleece. The following notes, taken from the University of California records, illustrate the way in which the data are kept.

A variation of more than 1.5 per cent in the yield of any set of three samples warrants repetition of the work.

[5] International Library of Technology 79 (Section 12):8. International Textbook Co., Scranton, Pennsylvania.

RECORD OF WEIGHINGS FOR CALCULATING THE SCOURED WEIGHT OF A FLEECE

Sheep No. *U. C. 402* Date sheared *3–24–'27*

Breed *Rambouillet* Days of growth *212*

Owner *U. of C.* Length of staple (inches) *1.87*

	grams		grams
Gross grease wt.	*6,722*	Gross machine wt.	*6,327*
Wt. of basket	*2,112*	Wt. of basket	*2,112*
(*a*) Net grease wt.	*4,610*	(*b*) Net machine wt.	*4,215*

(*c*) Loss in machine (*a*–*b*) *395* grams

(*d*) Per cent loss in machine $\left(\frac{c}{a}\right)$ 8.57

SCOURING RECORD OF SAMPLES

Sample No.	(*e*) Grease weight in grams	(*f*) Calculated original grease weight $\frac{e \times 100}{100\% - d}$ in grams	(*g*) Scoured weight bone-dry in grams	(*h*) Conditioned weight $g \times 1.16$ in grams	(*i*) Yield $\frac{h}{f} \times 100$ in per cent
1	*200*	*218.74*	*76.68*	*88.94*	*40.66*
2	*200*	*218.74*	*77.12*	*89.45*	*40.81*
3	*200*	*218.74*	*76.42*	*88.64*	*40.52*

Total *121.99*

(*j*) Average yield, per cent *40.66*

(*k*) Calculated clean wt. of fleece, less tags $\left(a \times \frac{j}{100}\right)$ *1,874* grams

(*l*) Clean wt. of tags (bone dry wt. × 1.16) *56* grams

(*m*) Calculated total clean wt. of fleece (*k* plus *l*) *1,930* grams

(*n*) Calculated total clean wt. of fleece (*k* plus *l*) *4.25* pounds

Work done by *J. F. Wilson* Date finished *7–11–'27*

ADVANTAGES OF THE CALIFORNIA METHOD

While this method of obtaining from small samples the shrinkage of an entire fleece leaves much to be desired, it has, nevertheless, certain advantages. First and chief among these is the fact that if mistakes are made subsequent to obtaining the net grease weight of the fleece, new samples may be obtained from the same fleece and the work repeated. Where whole fleeces are scoured, any error in weights or in scouring technique permanently vitiates the results. Second, there is no possibility of losing even small quantities of wool except through carelessness. Third, the method is simple. Fourth, it requires relatively small quantities of all supplies used in scouring. Fifth, if the work is properly done, the scoured stock will be cleaner and more attractive than that turned out by most commercial plants.

RESULTS OF WOOL-SCOURING TESTS[6]

In order to test the efficiency of the method described in the foregoing pages, a series of trials was concluded in the wool laboratory of the California Agricultural Experiment Station. The wool used was all California middle-counties fine, practically free. It was of about six months' growth and was taken from purebred Rambouillet wethers. Four fleeces were mixed by hand and the mixture was then twice put through the fleece breaker in order to insure as nearly a homogeneous stock as possible. One-hundred gram samples were then made up from this machined wool. The shrinkage figures in the following tables do not take into account the dirt removed by the machine, since the object of the work was merely to determine what differences, if any, were due to various conditions imposed on the wool.

Differences in weight due to variable atmospheric conditions were overcome by weighing all of the samples of any one experiment during a single hour; that is, all of the clean weights listed in table 1 were taken during the same hour. The clean weights shown in table 2 were likewise taken during a single hour, although not during the same hour as were those in table 1. In any one test, therefore, the results are strictly comparable, but the shrinkages of table 1 are not necessarily comparable with those of subsequent tables. The importance of taking into consideration the percentage of saturation of the air may be illustrated by the fact that the samples used in one series gained about 1.5 grams each during a single night.

[6] The author wishes to make grateful acknowledgment to Lowell Clarke, a student who performed much of the work incident to the data presented.

Effect of the Concentration of Soda Ash.—Table 1 represents an attempt to determine the differences in results due to various concentrations of soda ash. The results are presented in tabular form below.

Table 1 shows practically no difference in shrinkages obtained. Physical examination of the wool, however, revealed a greater harshness of feeling for all the samples above and including Na 100 than

TABLE 1

STRENGTH OF SODA-ASH SOLUTION

("Wyandotte" soda ash)

(Temperature, 125° F; time in each tub, 2 minutes)

Sample No.	Grams Soda Ash for each 7 gals. H_2O	Strength of solution—grams per liter Na_2CO_3'+ Na_2HCO_3	Grease weight samples	Scoured weight samples	Average yield of samples	Average shrinkage of samples
			grams	*grams*	*per cent*	*per cent*
Na 20	20	1.279	100	50.41	50.63	49.37
			100	50.85		
Na 40	40	1.850	100	49.96	50.22	49.78
			100	50.49		
Na 60	60	2.659	100	51.20	51.02	48.98
			100	50.84		
Na 80	80	3.192	100	50.57	50.57	49.43
			100	50.57		
Na 100	100	3.926	100	50.65	50.45	49.55
			100	50.25		
Na 150	150	5.592	100	51.58	51.42	48.58
			100	51.26		
Na 200	200	7.438	100	50.72	50.83	49.17
			100	50.94		

prevailed among the samples from Na 20 to Na 60. Samples Na 100, Na 150, and Na 200 possessed a wiry feeling and the wool, held close to the ear, did not have the proper 'drag.' The optimum amount of soda ash for best results will vary with the degree of hardness of the water used and with the type of wool being scoured. At Davis, where these tests were carried on, the water is moderately hard (0.5208 gram $NaHCO_3$ per liter) and a solution of 60 grams of soda ash to 7 gallons of water proved most satisfactory for all ordinary wools.

Effect of the Temperature of the Scouring Bath.—In table 2 the only variable was the temperature of the scouring bath.

While the average shrinkages obtained vary directly with the temperatures at which the wool was scoured, it is apparent from a study of the scoured weight of the samples, that the probable error of the average shrinkage is high, since one of the T 110 samples had exactly the same scoured weight as one of the T 150 samples. As was the case with series A, the greatest differences here were noticeable in the physical examination of the scoured wool. Sample T 110 was lofty, soft, and open, while T 150 was inclined to be harsh and dry. None of the wool, however, turned yellow.

TABLE 2

TEMPERATURE OF SCOURING BATH

(60 grams soda ash to 7 gals. H_2O; time, 2 minutes)

Sample No.	Temperature of bath	Grease weight samples	Scoured weight samples	Average yield of samples	Average shrinkage
	° F	*grams*	*grams*	*per cent*	*per cent*
T 110	110	100	50.85	50.87	49.13
		100	50.90		
T 125	125	100	50.55	50.82	49.18
		100	51.10		
T 135	135	100	50.57	50.74	49.26
		100	50.92		
T 150	150	100	50.85	50.42	49.58
		100	50.00		

A temperature of 125° F gives good results with most wools and has an advantage in that the operator quickly learns to tell by touch when the bath is approximately 125° F. This temperature is about as hot as the hand can bear. Exceptionally heavy wools and tags may be more thoroughly cleansed at from 135° to 140° F. For some types of wool, better results may be secured by having the bath in the second and third tubs about 10 degrees cooler than that in the first tub.

Effect of the Method of Agitation.—The third test was conducted to determine the advisability of gently stirring the wool with a paddle during its two-minute stay in each of the three tubs. The odd-numbered samples were so treated, while the even-numbered lots were agitated by raising and lowering the small screen-bottomed tub within the larger tubs and by turning it at the same time, a manipulation which caused considerable agitation of the scouring liquor.

TABLE 3

AGITATION OF WOOL WITH WOODEN PADDLES

(60 grams soda ash to 7 gals. H_2O; temperature, 125° F)

Samples scoured in numerical order

Wool agitated with paddle				Wool agitated by manipulation of small tub			
Sample No.	Grease weight	Scoured weight	Shrinkage	Sample No.	Grease weight	Scoured weight	Shrinkage
	grams	*grams*	*per cent*		*grams*	*grams*	*per cent*
P 1	100	50.52	49.48	P 2	100	51.64	48.36
P 3	100	51.20	48.80	P 4	100	51.27	48.73
P 5	100	51.00	49.00	P 6	100	51.74	48.26
P 7	100	50.55	49.45	P 8	100	50.75	49.25
Average			49.18	Average			48.65

The results presented in table 3 are fairly consistent and show that more foreign matter was removed from the wool by the slow and gentle action of the wooden paddle than was removed by the manipulation of the small tub. The paddle, properly used, takes the place of the 'rakes' in the commercial scouring plant. All of the samples stirred gently with the paddle were bright and open, while the others were decidedly ropy.

Effect of Using the Wringer.—Table 4 shows the desirability of using the squeeze rolls or wringer. Odd-numbered samples were scoured without the use of the wringer. After two minutes in each

TABLE 4

USE OF WRINGER OR SQUEEZE ROLLS

(60 grams soda ash to 7 gals. H_2O; temperature, 125° F; time, 2 minutes)

Samples scoured in numerical order

Samples not passed through squeeze rolls				Samples passed through squeeze rolls			
Sample No.	Grease weight	Scoured weight	Shrinkage	Sample No.	Grease weight	Scoured weight	Shrinkage
	grams	*grams*	*per cent*		*grams*	*grams*	*per cent*
W 1	100	51.90	48.10	W 2	100	50.55	49.45
W 3	100	52.18	47.82	W 4	100	51.20	48.80
W 5	100	51.82	48.18	W 6	100	51.10	48.90
W 7	100	51.62	48.38	W 8	100	50.85	49.15
Average			48.12	Average			49.07

bath, the sample was lifted out, allowed to drain for a moment and then immersed in the next tub. Even-numbered samples were treated exactly the same except that they were subjected to the wringer before passing from one tub to the next.

The data presented in table 4 show that the wringer is essential to proper scouring. The greatest shrinkage obtained among the four samples not passed through the wringer is less than the lowest shrinkage among the samples on which the wringer was used. The action of the 'squeeze rolls' forces the water out of the wool and the water carries with it some foreign matter which otherwise would not be removed. Furthermore, the difference in the appearance of the odd-numbered and even-numbered samples was very striking. Where the wringer was used the wool was of a whiter color and much more lofty than were the samples scoured in the absence of the 'squeeze.'

Effect of Scouring Many Samples Consecutively in the Same Solution.—Table 5 shows that many samples can be scoured consecutively in the same solutions without materially affecting the results. After sample 33 had been scoured, so much liquid had been removed from the tubs by lifting out the saturated wool that it was found difficult to immerse any more samples.

Before sample 33 (table 5) was scoured, the solution in the first tub had become heavily impregnated with dirt. Obviously each of the other two tubs contained an increasing amount of sediment as the work progressed. Tests of the scouring solutions were made at intervals to determine the percentage of sediment in the bath. Samples of 10 cc. of the solution were centrifuged for six minutes each. The results are shown in graphic form in figure 8.

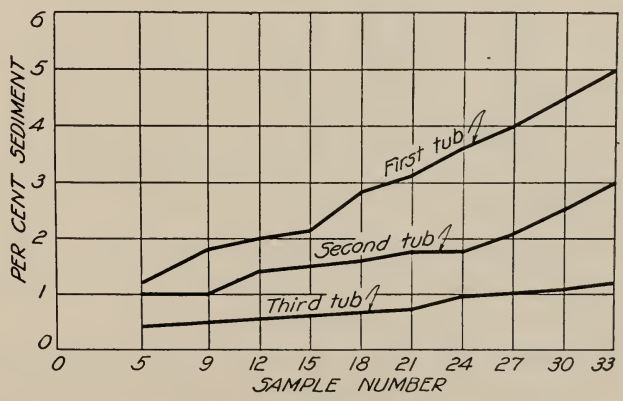

Fig. 8.—Percentage of sediment in scouring solutions (table 5).

The uniformity of results shown in table 5, despite an increasing sediment content in all three tubs, may be explained by the fact that the sediment has a tendency to settle quickly to the bottom of the tub. The screen bottom of the inner tub rests about an inch above the solid

TABLE 5*

MAXIMUM NUMBER OF SAMPLES WHICH CAN BE EFFECTIVELY SCOURED WITHOUT CHANGING THE SCOURING SOLUTION

(60 grams soda ash to 7 gals. H_2O; temperature, 125° F; time, 2 minutes)
Grease weight of samples 100 grams

Sample No.	Shrinkage	Sample No.	Shrinkage
	per cent		*per cent*
1	46.21	21	45.62
2	45.42	22	45.58
3	44.96	23	45.80
4	45.48	24	45.98
5	45.41	25	46.12
6	45.41	26	46.08
7	45.38	27	45.23
8	45.78	28	45.42
9	46.19	29	45.68
10	46.14	30	45.50
Average, 1 to 10....	45.638	Average, 21 to 30	45.701
11	46.14	31	45.67
12	45.36	32	45.18
13	45.95	33	45.13
14	45.35	Average, 31 to 33	45.326
15	45.13		
16	46.27		
17	46.15		
18	45.48		
19	45.74		
20	45.69		
Average, 11 to 20	45.726		

* The tests reported in tables 5 and 6 were conducted with a different lot of wool from that used in those reported in tables 1 to 4 inclusive.

bottom of the tub containing the scouring bath. Much of the sediment, therefore falls through the screen and rests on the bottom of the outer tub, where it is not in contact with the wool.

Table 5 indicates that for all scouring work not involving extreme accuracy of results, it is not necessary to change the scouring solutions often, and thus a considerable saving of labor and material is effected.

Effect of the Size of the Sample.—The amount of wool selected as a representative sample should, theoretically, be as large as possible and still permit efficient work and comparative ease of operation. The trial reported in table 6 was carried on in an attempt to determine the size of the sample which should be used.

TABLE 6

OPTIMUM SIZE OF SAMPLE FOR SCOURING

(60 grams soda ash; temperature, 125° F; time, 2 minutes)

Sample No.	Grease weight	Scoured weight	Shrinkage
	grams	*grams*	*per cent*
1	100	53.45	46.55
1A	100	53.55	46.45
2	200	107.30	46.35
2A	200	107.90	46.05
3	300	161.70	46.10
3A	300	162.50	45.84
4	400	216.45	45.89
4A	400	216.20	45.96
5	500	283.60	43.28
5A	500	277.95	44.41
6	600	327.55	45.41
6A	600	329.20	45.14
7	700	401.35	42.67
7A	700	394.65	43.62
8	800	453.70	43.29
8A	800	447.65	44.05
9	900	514.30	42.86
9A	900	507.15	43.65
10	1000	553.05	44.70
10A	1000	553.15	44.69

Table 6 indicates that with the equipment previously described, 100-gram samples or at most 200-gram samples will give more satisfactory results than samples of greater weight. The tendency in this test toward a general decline in shrinkage with an increase in weight of samples, indicates that less foreign matter was removed when the heavier samples were used. Furthermore, the variability in results tends to increase with the weight of the sample. Since samples of about 200 grams of wool, if properly extracted, will accurately represent the fleece, and are easier to handle than any larger quantity, it seems logical to use that amount in determining clean weights of fleeces.

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